Spring 5-11-2018

Evaluating Hand Hygiene Compliance Among Healthcare Workers in a Specialized Pediatric Hospital

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ABSTRACT

EVALUATING HAND HYGIENE COMPLIANCE AMONG HEALTHCARE WORKERS IN A SPECIALIZED PEDIATRIC HOSPITAL

By

ABIGAIL MONTEIRO

APRIL 6,2018

INTRODUCTION: Hand hygiene(HH) is an important prevention measure for reducing healthcare-associated infections(HAIs), but adherence to HH compliance is suboptimal by healthcare workers(HCWs).

AIM: The aim of this study was to measure the adherence of HH compliance of HCWs and to identify hindrances in non-compliance in a specialized care pediatric hospital in the United States.

METHODS: An observational study of compliance of HH practices among HCWs using the direct observation method was conducted over a two-month period in 2017 at two campuses of a pediatric hospital, by one trained observer. HH opportunities were defined by the World Health Organization's "Five Moments for Hand Hygiene" and the Clean-in and Clean-out Campaign.

RESULTS: A total of 2236 HH opportunities were observed during the two-month period with a compliance of 75%. HH compliance for both hospitals campuses differed upon entry and exit. Compliance did not vary significantly among hospital units and HCWs. Three barriers to HH compliance by HCWs appeared to be the most frequent; improper use of gloves, frequent entry and exit, and hands full with supplies.

DISCUSSION: The overall HH compliance among HCWs in the study was 76%, which exceeds the average reported compliance rate of 50%. Surveillance of HH is an important infection control policy that should be implemented by doing regular audits with feedback of results in an effort to encourage compliance.

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by

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B.S., GEORGIA STATE UNIVERSITY

A Thesis Submitted to the Graduate Faculty
of Georgia State University in Partial Fulfillment
of the
Requirements for the Degree

MASTER OF PUBLIC HEALTH

ATLANTA, GEORGIA
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APPROVAL PAGE

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ACKNOWLEDGMENTS

I would like to sincerely thank my thesis advisors Dr. Christine Stauber and Dr. Lisa Casanova for their continued guidance and patience throughout the development of my thesis. To my preceptor Cary Hilbert, thank you for allowing me to work on this project and providing me with your support and input in this process. I could not have asked for a better committee; without your help this thesis would not have been possible. I would also like to thank my family, friends, and Alex for their unwavering love and encouragement throughout this process and for always believing in me.

AUTHORS'S STATEMENT PAGE

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Introduction

Healthcare-associated infections (HAI's) are recognized as the root cause of increased morbidity, mortality, and escalating healthcare costs. HAIs can result in prolonged hospital stays, higher readmission rates, and can ultimately pose a significant risk to patient safety (WHO, 2011). According to a report by the Centers for Disease Control and Prevention (CDC) in 2011, hospital patients acquire an estimated 722,000 infections each year in the United States, which is about 1 infection for every 25 patients (CDC, 2016). The most vulnerable group to these HAIs is hospitalized infants and children. Young infants and children are susceptible to many infections because they have not yet fully developed their immune systems. Also, their behavioral characteristics such as incontinence, inadequate hygiene, frequent mouthing of hands, objects, and drooling facilitate the spread of infection (Moore, 2001). Patients can be exposed to a variety of microorganisms (bacteria, viruses, fungi and, parasites) during hospitalization. Some of the most common sources of infectious agents that could potentially be a source of HAI's is the patient itself, contaminated medical equipment, surrounding hospital environment, healthcare personnel, etc. (Collins, 2008).

The primary measure in preventing HAIs and enhancing patient safety is hand hygiene (WHO, 2009). Hand hygiene is the act of cleaning one's hands by washing them with soap and water, antiseptic hand wash or antiseptic hand rubs such as an alcohol-based hand sanitizer including foam or gel. Major contributors to the spread of HAI's are through person-to-person transmission via contaminated healthcare personnel's skin or contact through shared items and surfaces (Hassan, 2015). Several HAI outbreaks have been associated with contaminated

healthcare workers' hands (Chavali, 2016). "On average, healthcare providers clean their hands less than half the number of times they should" (CDC, 2017). Increasing hand hygiene has been shown to markedly reduce infections rates and considerably reduce the cross-transmission of multidrug-resistant pathogens (WHO, 2014). While hand hygiene has been proven to be a major infection control prevention approach, hand hygiene compliance remains alarmingly low, in the range of 30% to 50% (Boyce, 1999). Hand hygiene compliance levels are considered excellent at 90% or higher (WHO, 2014). It is believed that non-compliance by healthcare workers is triggered by inadequate time, heavy workloads, lack of education, and overall skepticism about hand hygiene as a preventative practice (Pittet, 2001). The challenge is to sustain high compliance rates among healthcare workers who directly work with patients and their immediate environments.

There are several different methods of measuring hand hygiene performance, such as direct observation of performances, conducting surveys using self-report of hand hygiene performance measuring product use and more recently using video and electronic surveillance monitoring systems. However, direct observation is the gold standard for measuring hand hygiene compliance. This approach is favored by the World Health Organization(WHO) as it can detect all hand hygiene opportunities, known as the "Five Moments for Hand Hygiene" (WHO, 2009). This method provides observers with quantitative and qualitative information to help identify barriers to compliance. The five moments for hand hygiene emphasizes hand hygiene before touching a patient, before clean/aseptic procedures, after body fluid exposure risk, after touching a patient, and after touching patient surroundings. Another movement that also identifies appropriate hand hygiene is the Clean-in and Clean-out Campaign, which asks all health professionals, clinical and non-clinical to clean-in and clean-out every time they enter and

exit a patient's room. The act of performing adequate hand hygiene is extremely important and is measured by CDC's recommended technique for using alcohol-based hand sanitizer and washing hands with soap and water. With alcohol-based hand sanitizer, each healthcare worker should perform adequate hand hygiene by putting the product on the hand and covering all surfaces of hands until dry with the recommended time of 20 seconds. With washing hands with soap and water, the technique is to wet hands first and then to apply the product to hands, rubbing hands vigorously for 15-20 seconds, covering all surfaces of the hands and fingers then rinsing hands with water and using disposable towels to dry and to turn off faucet.

Although the direct observation method of hand hygiene compliance is the standard practice, it is also subjected to biases such as the Hawthorne effect and interobserver variation (Guanche, 2017). The Hawthorne effect, also known as observer effect, refers to the tendency of people being observed in a research setting to alter their behavior from the way they would otherwise (Srigley, 2014). In this case, when a healthcare worker realizes that they are under observation, hand hygiene performance usually improves. Observer and selection bias can be minimized by validated observers, randomly choosing hospital units, healthcare workers and assessing compliance at various time points (Karaaslan, 2014).

While there have been several studies focused on healthcare worker's compliance and barriers, there are a lack of studies and attention relating to hand hygiene compliance in a pediatric hospital setting. This gap in the literature is surprising, children have developing immune systems and there is an overall lack of personal hygiene when they encounter physical contact with their peers, which can likely lead children to succumb to acute respiratory infections and gastrointestinal problems (Randle, 2013). Due to the limited studies on hand hygiene compliance in pediatric clinical areas, the purpose of this study was to measure the adherence of

hand-hygiene compliance of healthcare workers and to identify hindrances in non-compliance in a specialized care pediatric hospital in the United States.

Literature Review

I. Healthcare-associated infections and the impact it has in the pediatric population

Defined by CDC, HAI's are infection(s) that develops during hospitalization and after 48 hours or more following admission or within 10 days after being discharged following patient care (Collins, 2008). This new onset of the infection is unrelated to the illness that initially brought the patient into the hospital. HAI's occur in both adult and pediatric patients, however, bloodstream infections, viral lower respiratory tract infections such as pneumonia and urinary tract infections are the more prevalent HAI's associated with the pediatric age groups (Revelas, 2012). Amongst the pediatric population, infants with extremely low birth weight <1000 grams, children younger than 1 year and children in either the PICU or NICU have higher rates of HAIs (Revelas, 2012).

HAI's are most commonly caused by viral, bacterial, and fungal pathogens (Collins, 2008). During hospitalization, patients can be exposed to a variety of exogenous microorganisms through healthcare workers, visitors and via patient's own normal flora, which can harbor residual bacteria on the skin, mucosal membranes, gastrointestinal tract, or respiratory tract and may become invasive after surgical procedures or after the insertion of devices/catheters. (Collins, 2008). *Staphylococcus aureus* and *Escherichia coli* are organisms that live on the skin, however after being treated with broad-spectrum antibiotics this may destroy the susceptible part of the endogenous flora and instead patients become colonized with more resistant organisms from other patients, healthcare workers or from the hospital environment which can give rise to infections which can be difficult to suppress when immune function is low (Hans, 2012). Another source of exposure to potentially harmful pathogens is contaminated environmental surfaces or objects, such as patient's surroundings in their room (high touch surface areas,

equipment, and medications). Based on a scientific review of 1,022 outbreak investigations, the most common sources of infectious agents causing HAI's, are the individual patient, medical equipment or devices, the hospital environment, the healthcare personnel, contaminated drugs, contaminated food, and contaminated patient care equipment (Gastmeier, 2005). Among patients and healthcare personnel, microorganisms are transmitted to others by indirect contact via staff hands because hand hygiene is neglected or performed inadequately (Hans, 2012). Airborne spread is also another frequent mode of transmission; this is when small-particle-size microorganisms remain suspended in the air for long periods of time, they can spread to other people (Collins, 2008). The CDC has described an approach to reduce transmission of microorganisms through airborne spread by proper use of personal protective equipment (e.g., gloves, masks, gowns), aseptic technique, hand hygiene, and environmental infection control measures are primary methods to protect the patient from transmission of microorganisms from other patients and most importantly from healthcare worker (Collins, 2008).

There is a varying vulnerability in which patients can acquire an infection after exposure to an infectious organism. Patients who are immunocompromised due to age such as neonates and children have an increased likelihood of infection and susceptibility of pathogenic organisms due to their underlying disease condition, the severity of illness, immunosuppressive medications, or medical/surgical treatments (Collins, 2008). HAI's result in a prolonged length of stay, mortality and healthcare costs. In 2002, there were an estimated 1.7 million healthcare-associated infections occurred in the United States which resulted in 99,000 deaths (Klevens,2002). In March 2009, the CDC released an account estimating the annual direct medical costs of healthcare-associated infections ranged from $28-45 billion (Revelas, 2012).

II. Barriers to hand hygiene

There have been several reported barriers to appropriate hand hygiene. Some of the main reasons reported by health-care workers for the lack of adherence with hand hygiene recommendations include skin irritation, insufficient time, high workload, understaffed, high priority of patient needs, wearing gloves, forgetfulness, ignorance and disagreement with guidelines and protocols, inaccessible supplies, and lack of education on appropriate hand hygiene and scientific information demonstrating impact of improved hand hygiene on hospital infection rates, inconveniently located numbers of sinks; low risk for acquiring infection from patients and belief that glove use obviates need for hand hygiene (Pittet, 2001).

There is a perceived thought that wearing gloves might represent a barrier for compliance with hand hygiene, however, failure to remove gloves after patient contact or between dirty and clean body site care for the same patient constitutes noncompliance with the recommendations. The act of washing or reusing gloves between patient contact is ineffective, and handwashing or disinfection should be strongly encouraged after glove removal (Pittet, 2001).

III. Assessing various methodologies for hand hygiene measurement

The three main methods for measuring hand hygiene performance include measuring product use, conducting surveys and direct observation. Each method has its own advantages and disadvantages yet using more than one method to measure hand hygiene compliance can likely generate more reliable results than using one single method (The Joint Commission, 2009).

Measuring product use indirectly assesses hand hygiene guideline adherence by allowing healthcare workers to calculate the amount of liquid soap, alcohol-based hand rub, and paper

towels used in each area of the organization. This method is less expensive than observing healthcare workers directly and does not require as many staff members or as much training as the direct observation method (The Joint Commission, 2009). Measuring product use can be done at any time and in any place, and it permits the tracking of trends in the organization over time. Since measuring product use is discreet, it is less likely than the direct observation method to influence healthcare workers to change their hand hygiene behavior (The Joint Commission, 2009). Some disadvantages of this method are that measuring product use does not reveal whether healthcare workers are performing hand hygiene when it is indicated or whether they are performing it appropriately. This method does not generate any contextual information about when or why hand hygiene guidelines are not adhered to, and it often does not tell you who is or is not practicing hand hygiene (The Joint Commission, 2009). Furthermore, there are many elements make this measurement method prone to inaccuracy, including product waste or spillage, product use by patients and family members, and the borrowing of product between units (The Joint Commission, 2009).

Another indirect method of measuring hand hygiene is surveying healthcare workers, patients, and family members. These surveys can be conducted in person, over the telephone, electronically, on paper, through in-person interviews and focus groups which can yield information about perceptions, attitudes, and behavior related to hand hygiene. Through surveys, health care workers reveal what they know and think about hand hygiene as well as why they adhere (or do not adhere) to guidelines (The Joint Commission, 2009). Surveys can reveal whether health care workers' perceptions of their own hand hygiene behavior match the perceptions of patients and family members. However, using surveys for self-reporting of hand hygiene behavior can be unreliable; health care workers tend to overestimate their adherence to

guidelines when questioned and may inaccurately recall their past hand hygiene behavior (The Joint Commission, 2009). Using a well-designed and carefully administered survey whose validity and reliability have been established can help you achieve the most accurate results possible (The Joint Commission, 2009).

Direct observation, considered the gold standard of measurement according to the WHO, involves directly watching and recording hand hygiene behavior of healthcare workers and the physical environment. This direct method is the only way to assess the various aspects of hand hygiene such as observing the hand hygiene method that was used, the thoroughness of cleaning one's hands and the use of gloves. Most importantly it gives a visual to see the discipline of healthcare workers performing hand hygiene staff are performing hand hygiene when there is an opportunity to do so (The Joint Commission, 2009). These observations also create an opportunity to provide prompt feedback when improvement is deemed necessary. It can also provide quantitative and qualitative information about when and why noncompliance in hand hygiene occurs (The Joint Commission, 2009). Conversely, there are also limitations of the direct observation method. It can be labor-intensive and expensive and it requires the careful selection and training of those who will observe and record data (The Joint Commission, 2009). One of the biggest disadvantages of this method is that it can influence the behavior of those who know they are being observed (Hawthorne effect). This method requires strict guidelines in order to be successful such as who is going to be observed; who will conduct the observations; and when, where, and how often to observe the practice (The Joint Commission, 2009). The success of this method also depends on the accurate calculation of adherence rates and the careful training of data collectors (The Joint Commission, 2009). It is the only method available to detect all occurring hand hygiene opportunities and actions and to assess the number of times

and appropriate timing when hand hygiene action would be required in the sequence of care (WHO, 2009)

Methods

Study Design & Data Collection

The study of compliance of hand hygiene practices among healthcare workers was conducted over a two-month period in the Summer of June 2017 to the beginning of August 2017 at a pediatric hospital located in Metropolitan Atlanta, Georgia. Approved by the Institutional Review Board, study number H18259, to use secondary de-identified data of covert observations at two hospital campuses, by one trained observer. Hand hygiene surveillance performed at the first campus (Hospital A) included four intensive care units, four general patient care floors, and one other specialty care unit. Similarly, observations were also performed at the second campus (Hospital B) which is comprised of five intensive care units, four general patient care floors, and a specialty care unit.

The healthcare workers that were observed included physicians/residents/physician assistant's/nurse practitioner, nurses, allied health workers, techs, nursing/respiratory students, dietary, housekeeping staff, and other ancillary workers. One trained observer carried out the surveillance at both campuses twice a week and rounded at two different time intervals, starting at the beginning of the morning shift (8:00 am) and again at afternoon peak (12:00 pm). To warrant standardization and the reliability of the hand hygiene audits, units in each of the hospitals were put in a random generator which was then used to make a systematic time schedule for each campus. This was done to ensure that the observations at each unit or floor occurred at different time points to minimize any bias from occurring. At each hospital unit, hand hygiene audits were conducted for approximately 15-20 minutes totaling 5-hour

observation periods per day for the entire 2-month period. In total there were 2237 individuals observed during this two-month period, 1229 audits in hospital A and 1007 audits in hospital B.

The observer was trained to identify appropriate hand hygiene opportunities defined by the WHO's "Five moments for hand hygiene" and the Clean-in and Clean-out Campaign. The unit of observation was an opportunity for hand hygiene, defined as both before (one opportunity) or after (another opportunity) any contact with a patient or with an inanimate object inside the patient's room. For each opportunity, a type of hygiene such as handwashing, hand disinfection, glove change alone (without later hygiene), or no action and the timing of the activity (opportunity prior to or after an activity) were collected. Hand hygiene performance was not recorded or differentiated based on the type of washing, alcohol-based hand cleaner or soap and water. Using the Joint Commission Center for Transforming Healthcare hand hygiene targeted solutions tool, the compliance of healthcare workers was recorded. The data collection tool displayed in Figure 1. illustrates where the observer can note which healthcare workers were being observed and whether hand hygiene was performed on entry or exit. If a compliance opportunity was missed, a list of observable reasons can be recorded along with a comment section to note details of the observation being examined. Only the observable contributing factors section to washing was used for this study and the variables to non-compliance (missed opportunities) was recorded and coded as yes or no. For some hand hygiene audits that were marked as a missed opportunity, there was more than one observable reason that was recorded. The observable variables that were measured were as follows (The Joint Commission Center for Transforming Healthcare):

- Hands full of supplies: Hand hygiene was not performed due to healthcare provider's hands being full of supplies or equipment (e.g., food trays, lab supplies)
- Frequent entry and exit: Frequent entry and exit of patient care area without performing hand hygiene.
- Improper use of gloves: Healthcare provider did not wash hands before putting on gloves or after taking gloves off.
- Isolation area (gown + gloves): Prior to entering or exiting the isolation patient care area, the healthcare provider did not wash hands before or after putting on personal protective equipment (e.g., gloves or gowns, when required).
- Hands full of meds: Healthcare provider's hands are full of medications.
- Equipment shared: Healthcare provider did not wash hands due to the use of shared equipment between patients (e.g., vital sign machine, portable x-ray, etc.).
- Admissions or discharge process: Lack of streamlined admission or discharge process led to unnecessary, frequent entry or exit o the patient care area by the health care provider.
- Follow person entry or exit: Healthcare providers entering or exiting the patient care area followed someone who did not wash hands.
- Dispenser broken: The alcohol-based hand-rub dispenser(s) accessible to the observed health care provider is broken or not functional.
- Dispenser empty: The alcohol-based hand-rub dispenser(s) accessible to the observed health care provider is empty.

- Dispenser location: The alcohol-based hand-rub dispenser(s) is not optimally located in the path of the health care provider's workflow, and/or the access to the dispensers are either obstructed or hidden.

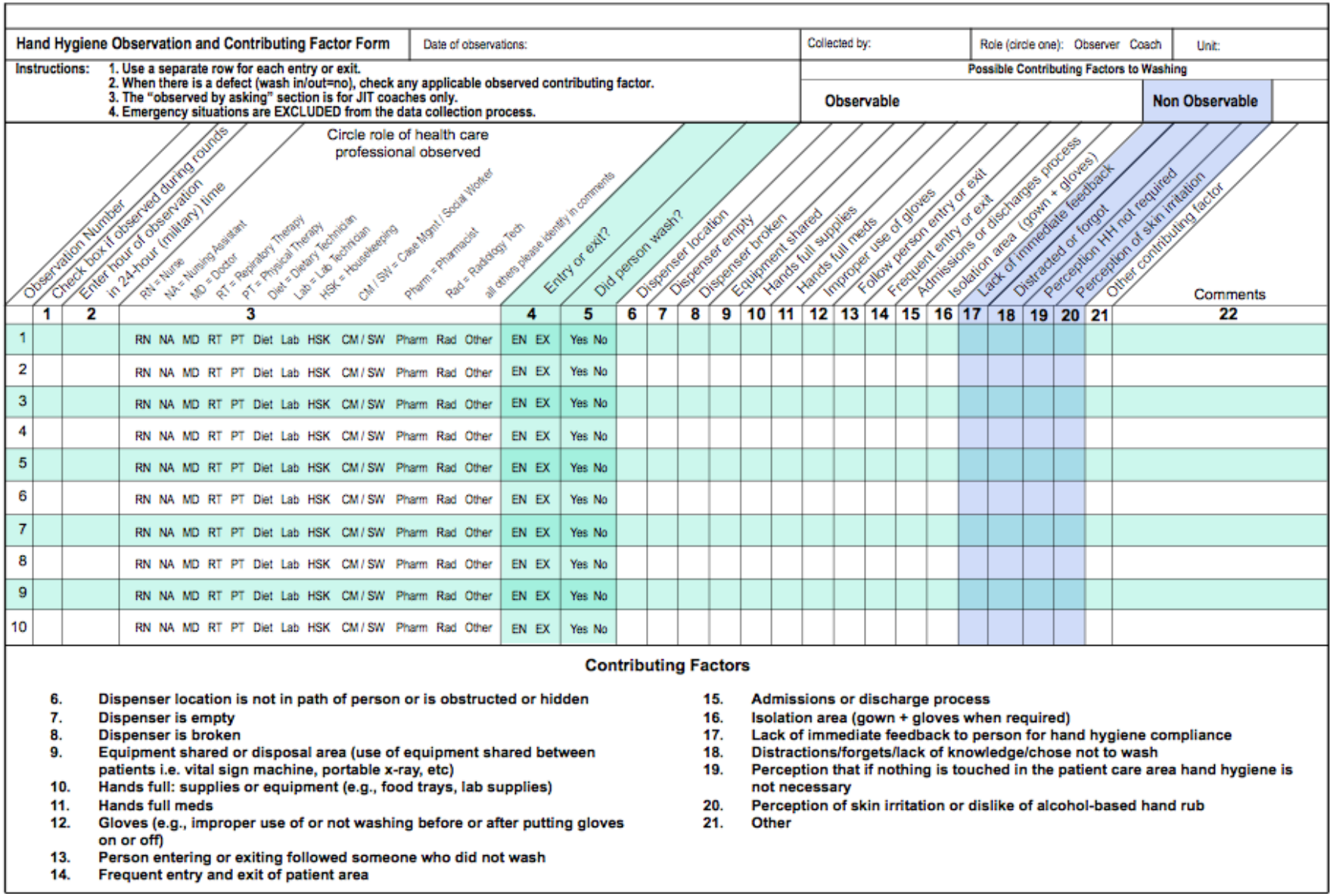
This same practice was followed thoroughly throughout the course of two months.

Data Analysis

All the secondary, de-identified data observed and collected using the tool was entered into the hospitals electronic data capture system (REDcap). Access to the hand hygiene compliance database system was granted in order to analyze hand hygiene compliance for this study. The Institutional Review Board(IRB) approved the study and the analysis was exempt from IRB since there was no identifying information.

All the observations from each day were summarized and each observable missed opportunity was examined and the barriers to compliance were identified. The percent hand hygiene compliance rate was calculated using the following formula; the number of times hand hygiene was performed divided by the total number of observed hand hygiene opportunities, multiplied by 100. In order to test whether compliance varied across healthcare workers, specific units, between entry or exit, and observable barriers, chi-square tests or the Fisher's exact test was used when applicable. A p-value of 0.05 was considered statistically significant and all analyses were performed using SAS 9.4 statistical software.

Figure 1. Data Collection Tool



Hand Hygiene Observation and Contributing Factor Form | Date of observations: | Collected by: | Role (circle one): Observer Coach | Unit:

Instructions:
1. Use a separate row for each entry or exit.
2. When there is a defect (wash in/out=no), check any applicable observed contributing factor.
3. The "observed by asking" section is for JIT coaches only.
4. Emergency situations are EXCLUDED from the data collection process.

Possible Contributing Factors to Washing

Observable | **Non Observable**

Circle role of health care professional observed

Observation Number	Check box if observed during rounds	Enter hour of observation in 24-hour (military) time	RN = Nurse, NA = Nursing Assistant, MD = Doctor, RT = Respiratory Therapy, PT = Physical Therapy, Diet = Dietary Technician, Lab = Lab Technician, HSK = Housekeeping, CM / SW = Case Mgmt / Social Worker, Pharm = Pharmacist, Rad = Radiology Tech, all others please identify in comments	Entry or exit?	Did person wash?	Dispenser location	Dispenser empty	Dispenser broken	Equipment shared	Hands full supplies	Hands full meds	Improper use of gloves	Follow person entry or exit	Frequent entry or exit	Admissions or discharges process	Isolation area (gown + gloves)	Lack of immediate feedback	Distracted or forgot	Perception HH not required	Perception of skin irritation	Other contributing factor	Comments
1	2	3		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1			RN NA MD RT PT Diet Lab HSK CM / SW Pharm Rad Other	EN EX	Yes No																	
2			RN NA MD RT PT Diet Lab HSK CM / SW Pharm Rad Other	EN EX	Yes No																	
3			RN NA MD RT PT Diet Lab HSK CM / SW Pharm Rad Other	EN EX	Yes No																	
4			RN NA MD RT PT Diet Lab HSK CM / SW Pharm Rad Other	EN EX	Yes No																	
5			RN NA MD RT PT Diet Lab HSK CM / SW Pharm Rad Other	EN EX	Yes No																	
6			RN NA MD RT PT Diet Lab HSK CM / SW Pharm Rad Other	EN EX	Yes No																	
7			RN NA MD RT PT Diet Lab HSK CM / SW Pharm Rad Other	EN EX	Yes No																	
8			RN NA MD RT PT Diet Lab HSK CM / SW Pharm Rad Other	EN EX	Yes No																	
9			RN NA MD RT PT Diet Lab HSK CM / SW Pharm Rad Other	EN EX	Yes No																	
10			RN NA MD RT PT Diet Lab HSK CM / SW Pharm Rad Other	EN EX	Yes No																	

Contributing Factors

6. Dispenser location is not in path of person or is obstructed or hidden
7. Dispenser is empty
8. Dispenser is broken
9. Equipment shared or disposal area (use of equipment shared between patients i.e. vital sign machine, portable x-ray, etc)
10. Hands full: supplies or equipment (e.g., food trays, lab supplies)
11. Hands full meds
12. Gloves (e.g., improper use of or not washing before or after putting gloves on or off)
13. Person entering or exiting followed someone who did not wash
14. Frequent entry and exit of patient area
15. Admissions or discharge process
16. Isolation area (gown + gloves when required)
17. Lack of immediate feedback to person for hand hygiene compliance
18. Distractions/forgets/lack of knowledge/chose not to wash
19. Perception that if nothing is touched in the patient care area hand hygiene is not necessary
20. Perception of skin irritation or dislike of alcohol-based hand rub
21. Other

Results

Overall HH Compliance among both hospitals

In the two-month data collection period, a total of 2236 hand hygiene opportunities were collected from hospital A and hospital B from each of the hospital's main wards, the intensive care units (ICU's) and general care areas. Overall hand hygiene compliance among both the hospitals was approximately 76% (Table 1). Hand hygiene compliance among the healthcare worker role ranged from a low 56% (for dietary workers) to an above average 86% (for physical/occupational therapists). Since there was such varying compliance among healthcare workers, the roles were further examined by grouping into those who had direct patient contact and those who did not have direct patient contact. When examining healthcare workers by categories and hand hygiene compliance, there was no statistical significance between those who had direct contact 75.8% (1535 of 2025) versus those who had indirect contact 74.4% (157 of 211) (p =0.6734). However, compliance differed by healthcare worker role as follows: physical therapist/occupational therapist had the highest compliance of 86%, EVS workers 80.6%, physicians/residents/PA/NP 80.3%, techs 76.7%, Nurses 76.3%, ancillary workers and other staff 75%, radiology 67%, respiratory therapists 65.2% and the lowest compliant group, dietary workers 56%.

In examining hand hygiene compliance among hospital units, results revealed that compliance did vary between hospital units (p = 0.0453). General care areas had higher compliance at 78.5%, whereas the intensive care units were 74.5% compliant. Analysis of the data did show significant variation between hand hygiene compliance in regards to entry and exit (p<.0001). Higher compliance of 82.7% was noted upon exiting of patient rooms, compared to a significantly lower compliance of 69.1% when entering patient rooms.

Table 1. Distribution of Hand hygiene Compliance for both Hospital Campus

	Percent HH Compliance N (%)	P-Value
Hospital Campuses		**0.0749**
Hospital A	948/1229 (77.1%)	
Hospital B	744/1007 (73.9%)	
Total	1692/2236 (75.7%)	
Entering or Exiting		**<.0001**
Exit	890/1076 (82.7%)	
Entry	802/1160 (69.1%)	
Hospital Units		**0.0453**
General Care	515/656 (78.5%)	
ICU	1177/1580 (74.5%)	
Role of HCW's		**0.6734**
Direct Care HCW's	1535/2025(75.8%)	
Physical Therapist (PT)/Occupational Therapist (OT)	43/50 (86%)	
Physician/Resident/Physician Assistant (PA)/ Nurse Practitioner (NP)	331/412 (80.3%)	
Nurse	908/1190 (76.3%)	
Tech	66/86 (76.7%)	
Respiratory Therapist	187/287 (65.2%)	
Indirect Care HCW's	157/211(74.4%)	
EVS	79/98 (80.6%)	
Ancillary & Other Staff	48/64 (75%)	
Radiology	16/24 (66.7%)	
Dietary	14/25 (56%)	

*p-value is significant at the level 0.05

HH compliance by Hospital A

The hand hygiene compliance for Hospital A was 77.1% with a total of 1229 observations collected. Compliance among the role of healthcare workers ranged from 60% to 87%. However, there was no statistically significant difference between compliance among healthcare workers that had direct patient contact 77.3% (841 of 1088) versus those who had indirect patient contact 75.9% (207 of 242) (Table 2).

However, there was variability among the nine healthcare worker groups examined and their compliance differed as follows; EVS workers 87.5%, Physicians/PA/NP 84.5%, physical therapists/occupational therapists 80.8%, nurses 78.3%, techs 77.6%, ancillary workers and other staff 73.5%, respiratory therapists 66.7%, dietary workers 62.5% and the lowest compliant group, radiology staff workers at 60%.

Conversely, in examining hand hygiene opportunities in regards to entry and exit, there was a substantial compliance difference (p <.0001). With an approximate 12% difference, compliance when entering a patient's room was remarkably lower at 71.6% than when exiting a patient's room at 83.5%. Assessing the relationship between hospital units and hand hygiene, there was no evidence of association for Hospital A (p = 0.4234). The percent compliance with hand hygiene amongst ICU staff was 76.4% (639 of 836) and that amongst general care staff was 78.6% (309 of 393). This can also be visualized in Table 3. when hand hygiene performance is evaluated among each hospital unit and unit size, there is no significant variation in percent hand hygiene compliance among the individual wards.

Table 2. Hand Hygiene Compliance for Hospital A

	Percent HH Compliance N (%)	P-value
Entering or Exiting		**<.0001**
Exit	480/575 (83.5%)	
Entry	468/654 (71.6%)	
Hospital Units		**0.4234**
General Care	309/393 (78.6%)	
ICU's	639/836 (76.4%)	
Role of HCW's		**0.7492**
Direct Care HCW's	841/1088(77.3%)	
Physician/PA/NP	136/161 (84.5%)	
PT/OT	21/26 (80.8%)	
Nurse	519/663 (78.3%)	
Tech	45/58 (77.6%)	
Respiratory Therapist	120/180 (66.7%)	
Indirect Care HCW's	107/141(75.9%)	
Ancillary & Other Staff	36/49 (73.5%)	
EVS	49/56 (87.5%)	
Dietary	10/16 (62.5%)	
Radiology	12/20 (60%)	

* p-value is significant at the level 0.05

Table 3. Hand Hygiene Compliance for Hospital a Examined by Unit and Unit Size

Hospital Units	Room Type	Number of beds in each unit	Total number of observations in each unit	Percent HH compliance by each unit
ICU				
PICU	Single Room	38	386	79.8%
NICU	Bay room/Single room	35	203	74.9%
TICU	Single Room	11	166	72.9%
CIRU	Single Room	29	81	71.6%
General Care				
PCA 1	Single Room	22	76	81.6%
PCA 2	Single Room	35	72	72.2%
PCA 3	Single Room	35	89	79.8%
PCA 4	Single Room	65	137	78.8%
AFLAC	Single Room	20	19	84.2%

HH compliance by Hospital B

Hand hygiene compliance for Hospital B was approximately 74% with a total of 1007 observations collected. Compliance among the role of healthcare workers ranged from 44% to 100%. However, there was no statistical significance in comparing hand hygiene compliance among healthcare workers that had direct patient contact 74% (694 of 937) versus those who had indirect patient contact 71.4% (50 of 70) (Table 4). Among the healthcare worker groups examined, there was variability by healthcare worker role as follows: radiology staff workers at 100%, physical therapists/occupational therapists 91.7%, ancillary workers and other staff 80%, physician/residents/NP 77.7%, Techs 75%, Nurses 73.8%, EVS workers 71.4%, respiratory therapists 62.6%, and the lowest compliant group, dietary workers at 44.4%.

Similar to Hospital A, when examining the hand hygiene opportunities in regards to entry and exit, there was also a substantial compliance difference (p <.0001). With an approximate 16% difference, compliance when entering a patient's room was significantly lower at 66% than when exiting a patient's room at 81.8%. Assessing the relationship between hospital units and hand hygiene, there was no evidence of association for Hospital B (p = 0.0604). The percent compliance with hand hygiene amongst ICU staff was 72.3% (538 of 744) and that amongst general care staff was 78.3% (206 of 263). However, when examining the hospital units individually and by hospital unit size, intensive care unit PICU is noted to be with the lowest hand hygiene compliance compared to all the other units. There is no significant variation in percent hand hygiene compliance among the other individual wards.

Table 4. Hand Hygiene Compliance for Hospital B

	Percent HH Compliance N (%)	P-value
Entering or Exiting		**<.0001**
Exit	410/501 (81.8%)	
Entry	334/506 (66%)	
Hospital Units		**0.0604**
General Care	206/263 (78.3%)	
ICU's	538/744 (72.3%)	
Role of HCW's		**0.6722**
Direct Care HCW's	694/937(74%)	
PT/OT	22/24 (91.7%)	
Physician/Resident/NP	195/251 (77.7%)	
Tech	21/28 (75%)	
Nurse	389/527 (73.8%)	
Respiratory Therapist	67/107 (62.6%)	
Indirect Care HCW's	50/70(71.4%)	
Radiology	4/4(100%)	
Ancillary & Other Staff	12/15 (80%)	
EVS	30/42 (71.4%)	
Dietary	4/9 (44.4%)	

* p-value is significant at the level 0.05

Table 5. Hand Hygiene Compliance for Hospital B Examined by Unit and Unit Size

Hospital Units	Room Type	Number of beds in each unit	Total number of observations in each unit	Percent HH compliance by each units
ICU				
PICU	Single Room	36	281	58.7%
NICU	Bay room/Single room	45	59	86.4%
TICU	Single Room	10	81	88.9%
CICU	Bay room/Single room	27	166	69.3%
CSU	Single Room	27	157	86%
General Care				
4 East	Single Room	28	73	76.7%
4 West	Single Room	17	66	78.8%
5 East	Single Room	32	73	80.8%
5 West	Single Room	18	35	80%
AFLAC	Single Room	10	16	68.8%

HH compliance by Hospital A PICU unit

A total of 386 hand hygiene observations were recorded from the PICU from Hospital A. The total compliance with this unit was approximately 80% (308 opportunities taken, out of 386). Also presenting similar results when examining entry and exit variable, compliance rates with hand hygiene procedures was substantially different among entry/exit ($p = 0.0014$). Performing hand hygiene after exiting a patient's room had higher compliance rates (86.4%) compared to when entering a patient's room (73.8%). (Table 6). Compliance among the role of healthcare workers ranged from 36.4% to 100%. However, there was no statistical significance ($p = 0.0745$) in comparing hand hygiene compliance among healthcare workers that had direct patient contact 80.9% (285 of 352) versus those who had indirect patient contact 67.6% (23 of 34). Among the healthcare worker groups examined, there was variability by healthcare worker role as follows: physical therapists/occupational therapists and ancillary workers and other staff 100%, tech 94.4%, nurses 80.4%, physicians/PA/NP 79.7%, respiratory therapists 79.5%, EVS workers 75%, dietary workers 50% and the lowest compliant group, radiology staff at 36.4%. There were four barriers to hand hygiene compliance that were examined in this unit. Improper use of gloves (39 of 386), frequent entry and exit (21 of 386), isolation area (14 of 386) and hands full of supplies (10 of 386).

HH compliance by Hospital B PICU unit

There were 281 hand hygiene observations recorded from the PICU from Hospital B. The compliance among this unit was much lower at approximately 59%. Examining entry and exit, produced similar compliance rates with hand hygiene procedures ($p < 0.0024$). Hand hygiene performance was still noted to be higher after exiting the patient's room (68.5%) than when entering (50.3%). (Table 7). Compliance among the role of healthcare workers ranged from

54.2% to 100%. However, there was no statistical significance (p = 0.1657) in comparing hand hygiene compliance among healthcare workers that had direct patient contact 58% (154 of 267) versus those who had indirect patient contact 83% (15 of 18). Among the healthcare worker groups examined, there was variability by healthcare worker role as follows: physical therapists/occupational therapists, ancillary workers and other staff, techs, radiology staff 100%, EVS 75%, physicians/residents/NP 64.1%, dietary worker 60%, respiratory therapists 56.5% and the lowest compliant group, nurses at 54.2%. There were five barriers to hand hygiene compliance observed in this unit. Frequent entry and exit (51 of 281), improper use of gloves (39 of 281), hands full of supplies (16 of 281), isolation area (11 of 281) and hand full of meds (3 of 281)

Table 6. Hospital Unit PICU for Hospital A (N=386)

	Percent HH Compliance HH opportunities/N (%)	P-Value
HH Compliance		
PICU	308/386(79.8%)	
Entry/Exit		**0.0014**
Entry	155/210 (73.8%)	
Exit	152/176 (86.4%)	
Role of HCW's		**0.0745**
Direct Care HCW's	285/352(80.9%)	
Nurses	160/199(80.4%)	
Respiratory Therapist	58/73(79.5%)	
MD/PA/NP	47/59(79.7%)	
Tech	17/18 (94.4%)	
PT/OT	3/3(100%)	
Indirect Care HCW's	23/34(67.6%)	
Radiology	4/11(36.4%)	
Ancillary & Other Staff	11/11(100%)	
EVS	6/8(75%)	
Dietary	2/4(50%)	
Barriers to HH Compliance	Missed HH Opportunities	
Improper Use of gloves	39/386(10.1%)	
Frequent Entry or Exit	21/386(5.4%)	
Isolation Area (gown + gloves)	14/386(3.6%)	
Hands full of Supplies	10/386(2.6%)	

* p-value is significant at the level 0.0

Table 7. Hospital Unit PICU for Hospital B (N=281)

	Percent HH Compliance HH opportunities/N (%)	P-Value
HH Compliance		
PICU	165/281(58.7%)	
Entry/Exit		**0.0024**
Entry	76/151 (50.3%)	
Exit	89/130(68.5%)	
Role of HCW's		**0.1657**
Direct Care HCW's	154/267(58%)	
Tech	2/2 (100%)	
PT/OT	2/2(100%)	
MD/Residents/NP	41/64(64.1%)	
Respiratory Therapist	26/46(56.5%)	
Nurses	83/153(54.2%)	
Indirect Care HCW's	15/18(83%)	
Ancillary & Other Staff	5/5(100%)	
Radiology	4/4(100%)	
EVS	3/4(75%)	
Dietary	3/5(60%)	
Barriers to HH Compliance	Missed HH Opportunities	
Frequent Entry or Exit	51/281(18.2%)	
Improper Use of gloves	39/281(13.9%)	
Hands full of Supplies	16/281(5.7%)	
Isolation Area (gown + gloves)	11/281(3.9%)	
Hands full of Meds	3/281 (1.1%)	

* p-value is significant at the level 0.05

Barriers to HH

Among all the hand hygiene opportunities that were recorded and identified, there were 544 missed opportunities that were detected, from which barriers to hand hygiene were acknowledged. From all of the observable barriers listed on the Joint Commission Center for Transforming Healthcare hand hygiene targeted solutions tool, only 6 barriers for non-compliance were recorded. Based on the analysis, it appeared that healthcare workers appeared to be less compliant with performing hand hygiene when gloves were improperly used, frequently entering and exiting a patient's room and when their hands were full with supplies (Table 8). The other 3 barriers, isolation area (gown and gloves), equipment shared and hand full of meds, were also reported in the healthcare worker's non-compliance; however, the these barriers were less frequently observed.

When further analyzing the observable barriers, it was noted that the healthcare professionals with the highest frequency for non-compliance within each barrier was prominent among the nurses, respiratory therapists and physicians/resident/PA/NP. Improper use of gloves was the most frequent barrier perceived to exhibit the most non-compliance among nurses, respiratory therapists and physicians/residents/PA/NP's as well as all staff examined in this study.

Table 8. Barriers to Hand Hygiene Compliance by HCW (N=544)

Observable Barriers	Definition	Role of HCW	Non-Compliant	Total N (%)
Improper Use of gloves	No HH before or after putting on gloves	**Direct**	**220**	255 (46.9%)
		Nurse	121	
		Physician/Resident/PA/NP	58	
		Respiratory Therapist	34	
		PT/OT	6	
		Tech	1	
		Indirect	**35**	
		EVS	15	
		Ancillary & Other staff	9	
		Dietary	6	
		Radiology	5	
Frequent Entry or Exit	Frequently entering or exiting a patients room without HH	**Direct**	**171**	180 (33.1%)
		Nurse	100	
		Respiratory Therapist	46	
		Tech	13	
		Physician/Resident/PA/NP	12	
		Indirect	**9**	
		Ancillary & Other staff	5	
		EVS	3	
		Dietary	1	
Hands full of Supplies	No HH performed due to hands full with supplies, equipment, food tray, etc.	**Direct**	**70**	80 (14.7%)
		Nurse	38	
		Respiratory Therapist	22	
		Tech	9	
		Physician/Resident/PA/NP	1	
		Indirect	**10**	
		Dietary	6	
		Ancillary & Other staff	2	
		EVS	1	
		Radiology	1	
Isolation Area (gown + gloves)	Gown or gloves are not used when required	**Direct**	**51**	56 (10.3%)
		Nurse	31	
		Physician/Resident/PA/NP	10	
		Respiratory Therapist	9	
		PT/OT	1	
		Indirect	**5**	
		Radiology	3	
		Ancillary & Other staff	2	
Equipment Shared	Equipment used between patients	**Direct**	**18**	18 (3.3%)
		Nurse	14	
		Respiratory Therapist	4	
Hands full of Meds	No HH due to hands full with medication	**Direct**	**5**	7 (1.3%)
		Nurse	5	
		Indirect	**2**	
		Ancillary & Other staff	2	

Discussion

Effective hand hygiene plays a significant role in the well-being of patients and healthcare workers. If hand hygiene compliance is not consistent and well maintained throughout hospitals, it can lead to health threats and put a major risk to patient safety, one being HAI's. The WHO's "Five moments for Hand Hygiene" and the Clean-in and Clean-out Campaign, represents a standardized approach for monitoring and implementing hand hygiene compliance.

The main aim of this study was to assess the adherence to hand-hygiene compliance and to identify hindrances in non-compliance among healthcare workers in a pediatric hospital. Such studies focused on pediatric populations is limited and have not been done previously in the United States and which solely examines healthcare workers' hand hygiene practices and factors that prevent proper hand washing. Unlike other studies on hand hygiene compliance, this study utilized the tools and methodology developed by WHO and the Clean-in and Clean-out Campaign to measure hand hygiene compliance among all respective hospital units and among all categories of healthcare workers that either exhibit direct patient care or indirect patient care when working in the hospital.

There are many factors that play a significant role in order to promote and maintain the highest level of hand hygiene compliance. Hospital facilities must validate that there are accessible hand washing supplies, resources to advocate hand hygiene awareness to healthcare workers and patients and hand hygiene-based training. In this study, it was noted that each patient room at both hospital campuses was sufficiently equipped with one alcohol-based hand sanitizer and one sink with antiseptic soap and paper towels. In any open-bay environments, alcohol-based hand rubs were accessible at every bedside and hand washing facilities were located within a short, accessible distance of every bed space. Also, outside every patient room

and bed space, alcohol-based hand rubs were strategically located and placed in clear eye-view so that hand hygiene performance cannot be missed. In addition, there were various hand hygiene posters placed strategically throughout the entire hospital, specifically on large display boards in the ICU and above most alcohol-based hand rubs to promote the importance of hand hygiene.

Direct observation in measuring hand hygiene adherence was the only method used in this study. Considered the gold standard in measuring hand hygiene compliance by WHO and also the preferred measure of compliance to similar studies in the literature, direct observation can help to determine the areas of weaknesses in hand hygiene behavior, to identify the number of hand hygiene opportunities and their indications, to assess techniques, and to provide feedback to healthcare workers. One of the biggest strengths of the study is that there was a large number of observations collected which gives a great overview on hand hygiene compliance within this pediatric setting. However, direct observation has its limitations; it is time-consuming, does not allow for continuous monitoring and more importantly, it has the potential bias of the Hawthorne effect. When the healthcare workers know that they are under observation, hand hygiene performance usually improves. This present study attempted to limit these issues by involving a single trained observer, strategically observing units at various time points, randomly observing healthcare workers, and collecting hand hygiene observations during the busiest hospital shift, day shift in order to blend in. Extra caution was utilized to ensure that none of the healthcare workers being observed were aware of the observer, as data was being collected during the two-time intervals. During the study period, if an opportunity of hand hygiene was missed, none of the staff received performance feedback. This study was solely performed to observe and evaluate healthcare workers hand hygiene compliance.

In this covert observation study, when healthcare workers were not aware they were being observed, hand hygiene compliance exceeded the national average reported compliance rate of 50% in similar studies done in other countries. Nevertheless, this study helped determine compliance among all variables such as hand hygiene performance upon entry and exit, compliance among healthcare disciplines, hospital units and the identification of hand hygiene barriers to determine further improvement in hand hygiene practices.

Direct observation helped reveal a particular low rate of hand hygiene compliance among healthcare workers upon entering patient rooms that was prevalent in both hospital campuses and in the largest intensive care unit, PICU. It was found that healthcare workers performed hand hygiene more often after patient contact when exiting a patient's room, while poorer hand hygiene adherence was observed on entry before having direct contact with patients. There have also been similar hand hygiene practice findings reported in literature which identifies that this gap in practice may be explained by lack of knowledge of hand hygiene guidelines or the desire on the part of healthcare workers to protect themselves from transmissible pathogens (Muhammad Ali Anwar, 2009).

When hand hygiene compliance was examined by hospital units among both campuses, the finding was statistically different, however when each campus was averaged individually there was no statistical significant differences between the ICU's and the general care areas. Also, hand hygiene compliance among healthcare worker groups divided into direct care and indirect care likewise revealed no statistically significant differences. Overall, physicians and nurses displayed high hand hygiene compliance rates. However, these high compliance rate findings are inconsistent with the majority of studies found in the literature review, where it is noted that physicians hand hygiene compliance is generally suboptimal (Squires, 2013).

Generally, while physicians and nurses tend to play a more direct role in patient care it is important to not overlook other specific healthcare disciplines that may also work with patients directly or indirectly. Often these disciplines are unobserved and have gone unmonitored in past studies, when they can also perform a substantial role in a patient's overall health care. The findings of this study displayed that PT/OT were the highest compliant in direct group, but it is important to point out that the number of observations in their discipline is also significantly less compared to other direct care roles. Respiratory therapists, being the third largest role observed had a compliance rate of 65%. While, this compliance is above the average rate of 50%, it still has much needed room for improvement. Since these staff members may come into more frequent contact with patients and near touch sites, thus theses healthcare staff need to be further evaluated in future studies.

Several barriers to hand hygiene were recorded in this study that can be used to have an overall explanation as to why hygiene practices were not performed appropriately. The main barriers to hand hygiene by healthcare workers displayed by descending order of frequency was improper use of gloves, frequent entry or exit, and hands full of supplies. Throughout the study it was noted that on several occasions that most healthcare workers did not perform hand hygiene before putting on their gloves. Some researchers have named glove use as one of the risk factors for poor adherence to hand hygiene and an increase in the risk of cross-infection. Frequent entry or exit has been observed many times in this study due to healthcare workers responding to alarming monitors, beeping medication pumps, responding to patient's needs, ventilator machines alarming, etc. Observations based on this barrier illustrated that healthcare workers would quickly enter the patients room and silence the machine and would then proceed to exit the room without performing hand hygiene. Hands full of supplies barrier was observed mainly

when healthcare workers had equipment in hand or procedure supplies and their hands were too full to perform hand hygiene. These barriers indicate some factors affecting compliance with hand hygiene such as lack of time, patients need taking priority and lack of knowledge of importance of hand hygiene in preventing cross infection. While these factors can only be assumed based on the barriers, it is important in future studies to get verbal feedback from healthcare workers when hand hygiene non-compliance is being observed.

There are numerous strategies developed by WHO and The Joint Commission for Transforming Healthcare, that have been implemented to increase hand hygiene compliance that have had an impact on healthcare worker's performance. The main tools that both organizations use is training, education, providing evaluation and feedback. These organization focus on the importance on educating all staff members and providing regular training on the importance of hand hygiene, based on the "My five moment's for hand hygiene" approach and on the correct procedure for hand rubbing and handwashing to all healthcare workers. Emphasis is placed on getting all healthcare workers into the habit of always washing in and washing out upon entering/ exiting a patient care area and before and after patient care. Strategies to improve compliance is also to monitor hand hygiene practices and infrastructure on a frequent basis. This along with engaging staff about related perceptions about hand hygiene can aid in an increase in compliance, while also providing performance and results feedback to the staff in real time. Coaching and intervening to remind staff to wash hands and by communicating frequently by providing visible reminders, can reinforce effective hand hygiene expectations. Holding everyone accountable for proper hand hygiene by applying progressive discipline from the top managers. Modify education in proper hand hygiene for specific disciplines and commitment to achieve hand hygiene compliance of 90% or higher. Continuous training, performance feedback

and verbal reminders will be needed to sustain adherence to hand hygiene. While hand hygiene practices in our study demonstrate that healthcare workers are generally complaint, there is always room for improvement. Further strategies and interventions are needed to refine evaluations of hand hygiene compliance among healthcare workers.

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